

Imperialism and Peace

Science and Freedom

In 1949, I saw that American scientists and intellectuals were greatly worried about the question of scientific freedom, meaning thereby freedom for the scientist to do what he liked while being paid by big business, war departments, or universities whose funds tended to come more and more from one or the other source. These gentlemen, living in a society where he who pays the piper insists upon calling the tune, did not seem to realize that science was no longer 'independent' as in the days when modern manufacturing production was still expanding at the lower stage of technical development, and the scientist who made the most essential discoveries was looked upon as a harmless individual toying with bits of wire, chemicals, perhaps collecting odd specimens in out of the many places. The scientist now is part of a far more closely integrated, tightly exploited, social system; he lives much more comfortably than Faraday, but at the same time under the necessity of producing regular output of patentable or advertising value, while avoiding all dangerous social or philosophical ideas. As a result, the worthies I mention were quite worried about the lack of scientific freedom in a planned society, but only indirectly and perhaps subconsciously as to what was actually happening to their own freedom in an age and time of extensive witch-hunting, where being called a communist was far more dangerous than being caught red handed in a fraud or robbery.

These considerations, however, are mentioned only because they lead one astray from the main facts. There is an intimate connection between science and freedom, the individual freedom of the scientist being only a small corollary. *freedom is the recognition of necessity; science is the cognition of necessity.* The first is the classical Marxist definition of freedom, to which I have added my own definition of science. Let us look closer into the implications.

As an illustration, consider the simple idea of flying. I am told that our ancestors in India had mastered some mysterious secrets of *yoga* whereby they could fly hundreds of miles in an instant. I don't believe it; these are flights of the fancy rather than of the body. Attempts to imitate the birds had very limited success, but gliders were more successful. Then came the posing of the elements of the problem, namely sources of power, methods of propulsion, laws of aerodynamics- all scientific and experimental truths. Mankind was not free to fly till the flying machine was invented. Today, anyone can fly without yoga- provided he has the means to enter an airplane. This, as society

and its property relations are constituted, implies that either he owns the plane, or someone who does allows him admission; ultimately, the question is whether or not our flying human has money, i.e. the necessary control over means of production. In the abstract, nothing prevents him from sprouting a pair of wings and flying off like a bird; nor from becoming a yogi and soaring into the atmosphere by mere exercise of will-power. Such freedoms nevertheless, are illusory; necessity compels man to find other, more feasible technical methods.

Take a commoner case, of eyesight. Five hundred years ago, extreme short sight or extreme farsight would have been regarded as varieties of blindness; they were written off as afflictions from heaven, or concomitants of old age. Glasses have to be invented for the restoration to normal sight of such people. This means today the science of optics, some knowledge of eye-structure, of glass, including its chemistry, lens-grinding technique, factories, and workshops. There are still many people who suffer from eye-defects that could easily be corrected by glasses; they are legally free to wear glasses. Only lack of funds prevents them. In India the number of pairs of glasses really necessary but not available would run into the millions.

We observe, then, that to recognize the necessity implies scientific experiment; in addition, there is a technical level which cannot be divorced from the experimental. Finally, there is a social structure that is not only intimately connected with the technical level, but also conditions the freedom of the individual by introducing a *social* necessity that in the abstract seems unnecessary but exists nevertheless.

Some of my statements about science are not likely to be disputed; that Science knows only one test, that of validity, of material proof. Science is nothing if it does not work in practice. Science is direct investigation of properties of matter, hence materialistic. Scientific results are independent of the individual who carries out the experiment, in the sense that the same action gives identical results. Finally, as the search for causes and their effects, science is cumulative: *science is the history of science*. Every scientific discovery of any importance is absorbed into the body of human scientific knowledge, to be used thereafter. Schoolboys can repeat Galileo's experiments, and first year college students learn more mathematics than Newton knew; the young students must go through much the same mental processes, stripped of inessentials and repeated according to modern points of view, when they study. But they do not have to read Galileo's dialogues, nor the *Principia*. Here science differs essentially from the arts, for in painting, the modern painter need not study the prehistoric bison in the cave of Altamira, nor the poet read Kalidasa. On the other hand, we can appreciate works of art and literature of all ages, for they are not subsumed in their successors in the manner of scientific discovery. Aesthetically, they have a survival value, a lack of obsolescence that the scientific work lacks. However, not all aesthetic effects have this survival value; the rapidly changing fashions that most ruling classes think necessary in their garments become as quickly ridiculous.

The other statements may also be briefly illustrated. Two painters painting the same scene will produce substantially different pictures; two people clicking the shutter of the same camera pointed at the same object will not. The fruits of ritual depend upon the rank of the celebrant, and only the king, medicine-man, shaman, or brahmin have the power or the right to draw down certain benefits for mankind; science tells us that these supposed benefits are imaginary, and fertility of the soil is better obtained by special agrotechniques, chemical fertilizers, and so on, than by fertility rites. Moreover, the chemicals and techniques work in the same way independently of who applies them.

Now I give these examples deliberately, because both art and ritual performed at one time the functions that have been displaced by scientific observation. Primitive ritual was a substitute for what we now call scientific theory though primitive technique was correct. In India the menstrual taboo is still observed, though dying out in the cities, where the hurly-burly of industrial life deprived it of all meaning. Our workmen worship their tools on one day in the year, a custom not without charm which can be traced back to the oldest known times; but lathes, turbines, electric motors and railway trains have made it clear that there is none of the workman's personal *mana* that resides in the tool. I note in the market that the humble vegetable vendor makes the first sale of the day with a humble salutation to the balances, and to the goddess Bhavani; the sharemarket speculator may spend considerable sums on astrologers, but doesn't neglect the market quotations, and relies upon study of trends and comers in shares, stocks, bonds, and such modern financial jugglery which is absent in his and the astrologer's scriptures. The millions that bathe even now at the time of a solar eclipse can point with pride to the fact that their prayers have been successful, that the sun has always been freed from the maw of the demon who swallows him; but astronomical theory which predicts the eclipse to the minute has crept into our traditional *pancanga* almanacs, through the Western ephemerides, so that people cannot really believe in what has come to be an obsolete practice. In *science, practice and theory cannot be divorced*. This does not mean that scientists have never held a wrong theory, but only that they keep on making better and better approximations to the truth, knowing that there is no final truth simply because the properties of matter are infinite and inexhaustible. In ritual, no one dares make an experiment; the older the precept the more sure its grip.

Religion develops from ritual when primitive society acquires a class structure, a tighter organisation of its originally varied components into a larger whole. This need not be elaborated here. What most of us do not realize is that science is also a social development; that the scientific method is not eternal and that *science came into being only when the new class structure of society made it necessary*. Of course, science really comes into its own with the machine age, which cannot develop without science and which in turn contributes highly useful technical aid to scientific discovery. But the fundamental inner connection is that machine production, like science, is cumulative. The machine accumulates human labour time towards the fulfilment of a

specific human purpose. Yet modern science, as we know it, came into being before the machine age, and for the same purpose, namely to serve the new social needs. *Moddem science is the creation of the bourgeoisie.*

One of the major contributions of science is that it separates theory from technique, specifically from productive technique. If you look at our village workmen, you find them still producing excellent work with quite inferior tools simply because the workman masters the individual tool, makes it an extension of his person. Only he can handle the particular bit of metal efficiently enough to obtain good results. But his production is not standardized. If he makes two complicated devices of the same type, the parts will not be interchangeable, though both may have the same design and function. In the modern factory, on the other hand, the lathe or the loom is independent of the person handling it, just as the scientific experiment is independent of the experimenter, provided in each case the worker has the minimum efficiency necessary to keep the mechanism from damage. A village weaver is whole ages and social layers apart from the village potter; a worker on the assembly line can easily shift from one type of factory to another. In the case of the handicrafts-man, theory is not divorced from the tool, his knowledge is acquired as well as expressed through his fingers. The result is that the transmission of such knowledge is slow, craft workers tend to form into closed guilds (in India small sub-castes), and a long apprenticeship is necessary for the production of more workmen, their numbers and production being severely limited. This was the situation in Renaissance Europe, for example, when considerable accumulation of money with the merchant princes (and its overflow) made it necessary to find new methods of making money grow. The older usury was limited in scope: more than a certain profit could not be extracted from the debtors tied to the older mode of production. Confiscating the mortgaged tools of a craftsman may lead to starvation for him and his family but the tools are unproductive bits of metal and wood to the usurers. There is needed a new class which can produce goods efficiently without long training, and whose surplus labour can be appropriated by an employer. This turns the mere usurer into a capitalist, the craftsman into a proletarian. But to manage such enterprises, there is needed some theory of material processes that works in practice, and serves the managing class which does not handle the tools of production. This is precisely the role of science. If you look into Galileo's researches, for example, you will find them concerned with such practical things as why pumps don't suck up water above a certain height -which leads to hydrostatics, and also to better pumps. Accurate time-keeping is made possible by his observations upon the pendulum; but it is factory production, where many men have to be brought together simultaneously for coordinated labour, that needs accurate time-keeping; not cottage industries. Galileo cast or recast horoscopes, rather badly. His astronomy was revolutionary because he turned a telescope upon the heavens, to interpret what he saw in a perfectly natural manner. The man in the moon disappeared, to be replaced by mountains. But what made his astronomy dangerous was the fact that it shook a system of the universe taken for granted by the ruling class and by the church that

served it; by implication, the rest of the social system was also laid open to challenge, something that no man is free to do without risk.

Science is not mere accumulation of experimental data. No experiment is great unless it settles some disputed theory; no theory is a striking advance unless it explains puzzling experimental data, or forecasts the results of unperformed experiments. But one has only to look at the way the scientific centre of Europe has shifted to see the intimate connection between science and production, between the coming to power of a new bourgeoisie and the local age of discovery. Leeuwenhoek was a janitor in Delft who ground his own lenses and made the first good microscopes, which he turned upon drops of water and the smallest insects. It was the Royal Society of London that sent its secretary to visit him, and published his papers, just as they published Redi's communications against the doctrine of spontaneous generation, which helped solve the very practical problem of food storage. But the idea of giving credit to him who publishes first is comparatively new. Even Newton did not like to give away his discoveries light-heartedly, and the further back we go the stronger we find the tendency to keep a precious secret concealed as a monopoly. It is the social mode of production that changes the fashion, though private ownership of the means still insists upon patents, cartels, monopolies at level of technique and manufacture. Now is it an accident that the very century during which two revolutions placed the bourgeoisie in power in England produced Newton? How is it that the French revolution, which cleared off the rubbish of feudalism in France saw the greatest of French anti European scientists: Lagrange, Laplace, Ampere, Berthelot? They rose with the bourgeoisie and survived Napoleon. Gauss, the great name in German science, appears on the scene at about the time the German bourgeoisie becomes the real power in its own country; and he is not alone. If we wrote all these off as accidents, we should be in the ridiculous position of denying the possibility of a scientific basis for the origins of science, by taking the history of science as a series of fortunate coincidences, though science is its own history and has always progressed by seeking the reason behind suspicious coincidences. I might go further and say that Greek science was (in spite of all the admiration lavished upon it, and in spite of its logical method having served as inspiration to the Renaissance) not science in the modern sense at all, but pseudo-science, much as Greek and Roman capital can at best be called pseudo-capital in spite of modern imperialist tendencies and actions. The aim of Greek science was to reduce all phenomena to reasoning from the techniques that had originated the very discoveries. That too was a social necessity, for in classical society the work was done by slaves, whose existence was taken as a law of nature, a necessity which reflected itself in the scientific outlook of the time.

This should dispose of the idea that science is the creation of gifted individuals, thinking for 'purely' scientific purposes along problems which came to them out of some realm of the mind. There are gifted individuals in every age and society. but the manner in which they exercise their gifts depends upon the environment, just as much as the language in which they choose to do their thinking. It is as impossible for the

mind to exist without thought as for the body to exist without motion. There are still people in India who speculate upon the relative merits of Sankara's and Ramanuja's philosophy, though they do not thereby presume to acquire the prominence of those two founders. If I repeat Newton's experiment with the prism, I shall get the same results, but certainly not the same credit as a scientist or founder of optics. *The weight, the significance of a scientific discovery depends solely upon its importance to society.* This is why the college student, knowing more mathematics than all of Newton's contemporaries, is still not a prodigy. A discovery that has been assimilated is reduced to the level of useful technique. A discovery made before it is socially necessary gains no weight and social necessity is often dependent for its recognition upon the class in power. Leonardo da Vinci, whose 500th anniversary is now being celebrated, is the most famous example of this. He still served feudal masters, who were not interested, for example, in the manufacture of pins (from which Leonardo expected to make a fortune), and who used his mechanical talents for stage effects. A hundred years later, his fame as an artist would have been far less than an inventor. That social development, both in technique and in needs of production, evoked scientific discovery long before the days of organized research is clear from the independent and simultaneous discoveries made so often in the history of science. For example, the liquefaction of gases, so long considered an impossibility, was done by two different people in France at once. The Raman effect, whose theory is still imperfect, was discovered simultaneously in the USSR and India. The credit rightly belongs to Raman, who realized at once that while the rest of the world had been looking for an atomic effect, this was a molecular phenomenon. The experiments he devised proved it, and gave us a valuable technique of analysis which does not change the substance.

But occasionally, as with Priestley, the conflict between the scientist and the class that dominates society becomes too great for the individual and for his discoveries to gain proper recognition. This is not a characteristic merely of the bourgeois period. During the middle ages, we find Europeans turning to meditation, the monastic life, theological speculation. Such tendencies were highly respected and advertised, with the assistance of an occasional miracle. However, the theology was not independent of the class structure of contemporary society; dangerous speculations led a man to the stake. Not only feudal rulers, but the later merchant classes used theology, protestantism in the latter case. The early saints and martyrs upon whose reputation the church was apparently founded, did not suffice in the later period. When the Church itself became a great holder of feudal property, abbacies and bishoprics turned into the prerogatives of particular rich families, or groups of families; this happened, incidentally even with Buddhism as may be seen from the history of the Barmecides, or of the few ruling families of Tibet till its recent liberation, or from the history of the richer monasteries in Ceylon. The foundations of Sankara, Ramanuja, and even a real people's saint like Tukarama are now chiefly preoccupied with methods of increasing their wealth, retaining outworn prerogatives, avoiding taxes. The wealthy Church in Europe needed the Inquisition to support its claims; that holy office found Galileo's thought

dangerous. The crusades were diverted to strange aims, such as the conquest of Constantinople, and the suppression of a popular movement in the Albigeois. The Index Expurgatorious shows the church's attitude towards certain type of advanced thinking, while the last Spanish civil conflict demonstrated what steps the church in Spain, as Spain's greatest owner of property, was capable of taking against a democratic government.

A fairly close parallel could be drawn on the thesis that science is the theology of the bourgeoisie; at least it replaces theology whenever the bourgeoisie- capitalist mode of production displaces the feudal. The scientist must remain comparatively poor like the monk, but is admired, admitted to the board of the capitalist baron just as the cleric was to that of the feudal lord. His discoveries must be patentable, but he rarely makes the millions; Pasteur and Faraday received a beggarly pittance of the profit made from their discoveries. A press-agent may make the scientist's miracles known, but only if they are acceptable to the lord of the press, hence to the ruling class. And most striking of all, in the period of decay, witch-hunting is as prominent in its own way as with the end of feudalism.

Though a creation of the bourgeoisie, science is not its monopoly, and need not decay with the bourgeoisie. The art of dancing began as part of ritual, but is now one of society's aesthetic pleasures even though the witch-doctors who initiated it have mostly vanished. Music is no longer necessary to promote the growth of plants; even as I write, I can hear the primitive rhythm of tomtoms and ancient chants being practised at midnight- not for better crops but for the sake of some relief from the daily grind of life by people who are milkmen, factory workers, and house.servants. Sculpture does not mean the underground mysteries of pre-historic French grottos; the Parthenon statuary is admired in the British Museum, but no longer worshipped. There is no reason for science to remain bound any longer to the decaying class that brought it into existence four centuries ago. The scientist needs this freedom most of all, namely freedom from servitude to a particular class. Only in science planned for the benefit of all mankind, not for bacteriological, atomic, psychological or other mass warfare can the scientist be really free. He belongs to the forefront of that great tradition by which mankind raised itself above the beasts, first gathering and storing, then growing its own food; finding sources of energy outside its muscular efforts in the taming of fire, harnessing animals, wind, water, electricity, and the atomic nucleus. But if he serves the class that grows food scientifically and then dumps it in the ocean while millions starve all over the world, if he believes that the world is over-populated and the atom-bomb a blessing that will perpetuate his own comfort, he is moving in a retrograde orbit, on a level no beast could achieve, a level below that of a tribal witch-doctor.

After all, how does science analyse necessity? The sciences are usually divided into the exact and the descriptive, according to their being based upon a mathematical theory or not. This distinction has faded away because the biological sciences have begun to feel the need for exact numerical prediction, while physics and chemistry have

discovered that, on the level of the individual particle, exact prediction is not possible as with the movement of the solar system. Both have found the new mathematical technique, based upon the theory of probability, that they need. In the final analysis, science acts by changing its scene of activity. It may be objected that astronomy does not change the planets or the stars; is it not purely a science of observation? Astronomy first became a science by observing the changes in the position of heavenly bodies. Further progress was possible only when the light that reaches the astronomer was changed by being gathered into telescopes, broken up by passage through spectrographs, or twisted by polarimeters. Parallel observations of changes, say in metallic vapours, in the laboratory enabled conclusions to be drawn about the internal constitution of the stars. There is no science without change.

If this be admitted, we are near the end of the inquiry. The reason why the scientist in a capitalist society today feels hemmed in and confined is that the class he serves fears the consequences of change such as has already taken place over a great part of the world's surface. The question of the desirability of such change cannot be discussed dispassionately, cannot be approached in a scientific manner, by the supposedly 'free' scientist. The only test would be to see the two systems in peaceful competition, to see which one collapses of its own weight, succumbs to its own internal contradictions. But the scientist who says that this should be done finds himself without a job if he is on the wrong side of the "iron curtain". The real task is to change society, to turn the light of scientific inquiry upon the foundations of social structure. Are classes necessary, and in particular, what is the necessity for the bourgeoisie now? But it is precisely from cognition of this great problem of the day that the scientist is barred if a small class should happen to rule his country. Perhaps the crisis cannot be considered immediate in new democracies like India, where the bourgeoisie is itself a new class? This is incorrect. The new class did not develop its own science any more than it invented its own Indian steam engine and motor car. Just as they import the best paying machinery, the science they need is also imported in ready-made form. They are also ready to import any political ideology that serves their end. This means that instead of the centuries of development from medieval to modern as in Europe we can expect at best decades in India, under the leadership of a bourgeois-capitalist class that has only re-oriented but not lost its colonial mentality.

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